Executive Summary

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SYNOPSIS

The proposed action is to maintain and improve the navigation channel in order to enhance commercial navigation on the MKARNS, while maintaining the other MKARNS project purposes. The proposed action involves implementing actions associated with three elements that influence navigation on the MKARNS. These three elements are 1) Navigation Channel Depth Maintenance, 2) River Flow Management, and 3) Navigation Channel Depth Increase.

Multiple alternatives for accomplishing each of the three elements of the proposed action (as well as No Action) are presented and evaluated in this EIS. The effects of the proposed action on the environment and on socio-economic conditions are analyzed in this document. The EIS identifies Alternative E as the preferred Army action combining: 1) Navigation Channel Depth Maintenance – New Disposal Sites, 2) Flow Management – Operations Only, 3) Navigation Channel Deepening – 12 foot Navigation Channel Mouth to Catoosa .

Implementation of the proposed action is expected to result in beneficial as well as adverse impacts to the environment under any of the alternatives. In general, adverse impacts would be greatest under those alternatives requiring higher levels of disturbance to the existing environment. The preferred alternative was selected based on an evaluation of beneficial and adverse impacts associated with implementing any of the alternatives. The Army's preferred alternative provides a balance between benefits and impacts that results in a project with minimal adverse impacts (after mitigation) that achieves the purpose of the study.

The results of Arkansas River Navigation Study are presented in the Feasibility Study Report that is a separate document from the EIS. As presented in the Feasibility Study Report:

1) total project cost of implementing Alternative E is $166, 418, 500,
2) total annual costs are $12,472, 800,
3) total annual benefits are $22,283,300,

4) net benefits are $9,810,500, and
5) benefit-to-cost ratio is 1.8.
6) the incremental net benefits from channel deepening are $1,009,800 with a benefit to cost ratio of 1.08.

ES.1 Introduction

The U.S. Army Corps of Engineers' (USACE) Civil Works programs include: navigation; flood and storm damage reduction; hydropower, environmental stewardship; ecosystem restoration, water supply, recreation, and regulation of work by others in waters of the United States. By supporting navigation on the McClellan-Kerr Arkansas River Navigation System (MKARNS) , USACE can improve its contributions to national welfare and the accomplishments of the civil works mission. Maintaining a channel means keeping the channel at specified depths and widths by dredging and other means. Therefore, the USACE seeks to improve commercial navigation on the MKARNS system. Specifically, the Little Rock and Tulsa Districts of the USACE constructed the MKARNS and are charged with the operation and maintenance of the system for commercial navigation and would accomplish this action while maintaining other project purposes of: flood control, recreation, hydropower, water supply, and fish and wildlife.

Commercial navigation is an historic and ongoing activity on the MKARNS. Three features associated with the maintenance and improvement of the MKARNS are considered in this document:

1) Navigation Channel Maintenance: The ongoing operation and maintenance of the existing 9-foot navigation channel on the MKARNS, entails the use of "river training structures" as well as periodic dredging at some locations within the navigation channel. Since the completion of the MKARNS in 1971, some authorized dredged material disposal sites have reached capacity and new disposal sites are required to continue channel maintenance activities. Additionally, the construction of new river training structures would facilitate the maintenance of the 9-foot navigation channel.

River training structures, such as dikes and revetments, are stone structures commonly used for training navigation channels and stabilizing shorelines. Dikes run perpendicular to the river and force the water flow away from the bank causing higher flow velocities and thereby scouring the navigation channel to a depth required for safe navigation. Revetments run parallel to the river and are an orderly facing of stone or broken concrete along a slope to prevent erosion. River training structures have several functions including:

- direct the river flow through the navigation channel;
- constrict the channel to increase velocity and thus deepen it (benefiting navigation);
- prevent erosion on susceptible banks; and
- create slack water for marinas and boat launches.

2) River Flow Management: Sustained high flows on the MKARNS have adversely influenced the safety and efficiency of commercial navigation operations and have resulted in

flood damages along the river. The reliability and predictability of river flows affect navigation traffic utilization of the MKARNS.

3) Navigation Channel Depth: Commercial navigation is not at optimum productivity within the MKARNS since its 9-foot draft navigation channel limits towboat loads compared to the Lower Mississippi River's authorized 12-foot draft channel.

ES.2 Arkansas River Navigation System

The Arkansas River Navigation Study geographically encompasses the MKARNS from the Port of Catoosa near Tulsa, Oklahoma downstream to its confluence with the Mississippi River in southeastern Arkansas, as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS.

The MKARNS is approximately 445 miles in length and includes a series of 18 locks and dams that provide for commercial navigation throughout the length of the MKARNS.

River flows on the MKARNS are primarily influenced by rainfall in the upper Arkansas River watershed upstream of its confluence with the Verdigris River (river mile 394); as well as water storage and release from 11 reservoirs in Oklahoma. The 11 Oklahoma reservoirs are:

- Keystone Lake
- Oologah Lake
- Grand Lake o' the Cherokees (Pensacola Dam)
- Lake Hudson (Markham Ferry Dam)
- Fort Gibson Lake
- Tenkiller Ferry Lake
- Eufaula Lake
- Kaw Lake
- Hulah Lake
- Copan Lake
- Wister Lake

ES.3 Proposed Action

The proposed action is to maintain and improve the navigation channel in order to enhance commercial navigation on the MKARNS, while maintaining the other MKARNS project purposes of flood control, recreation, hydropower, water supply, and fish and wildlife. The proposed action for achieving the study objectives consists of three features that influence navigation on the MKARNS. These three features are:

- Navigation Channel Depth Maintenance,
- River Flow Management (reduce high flows), and
- Navigation Channel Deepening.

ES.4 Alternatives

The formulation of alternatives began by identifying features and components within each feature that meet the planning objective of providing a safe, reliable, efficient, and sustainable MKARNS navigation channel. Alternative formulation was an iterative process that started by identifying potential measures to achieve the proposed action and subjecting them to a screening process that resulted in the selection of the viable components that make up the alternatives. Both components and alternatives underwent detailed analysis.

The alternative development and analysis for this study included:

- Features. Features are broad actions that influence the attainment of the proposed action;

- Components. Components are one or more specific actions that address the attainment of the proposed action within a feature; and

Alternatives. Alternatives are combinations of components, among one or more features, that specifically address the attainment of the proposed action. Selection of the preferred alternative to implement the proposed action is the "Decision to be Made" by the USACE.

ES.4.1 Navigation Channel Depth Maintenance Feature

The proposed Maintenance Dredging and Disposal Action is to maintain the existing 9-foot navigation channel via the existing river training structure system and maintenance dredging.

As part of the ongoing operation and maintenance of the designated 9-foot navigation channel on the MKARNS, periodic dredging is required in some locations within the river. Since the completion of the MKARNS in 1971, some authorized dredged material disposal sites have reached capacity (primarily in Oklahoma) and new disposal sites are required to accommodate continued navigation channel maintenance activities. The sites with remaining capacity, particularly in Oklahoma, have not been used since authorization and some have mature vegetation now. Therefore, use of those existing sites may require additional mitigation because of major adverse impacts to terrestrial habitat.

River training structures are also an important tool in maintaining navigation channel depth. The existing river training structure system on the MKARNS functions to reduce the need for maintenance dredging, however, new structures may be needed to facilitate the maintenance of the 9-foot navigation channel.

The screening process included the evaluation of a range of components to determine which were viable for implementation. Based upon the review process, one component was eliminated and two components were selected for detailed analysis. Eliminated from consideration was the component which would have dredge disposal materials transported to previously approved dredge disposal sites. This component was eliminated because it required transporting dredged material distances that were not viable or practical. The components include the No Action Component as well as two viable implementation components.

- Component 1: No Action; This component involves disposing of dredged material only in active disposal sites. At this time, this component is not viable or practical and will not be evaluated as part of this study.
- Component 2: Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan; After currently utilized disposal sites reach their capacity, dredged material would be disposed of at unused sections within areas approved in the 1974 O&M Plan and Environmental Impact Statement (EIS), regardless of the quality or type of habitat present., and
- Component 3: Maintenance Dredging and Disposal – Maintenance Dredged Material Disposal in New Disposal Sites; After currently utilized dredged material disposal sites reach their capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term Dredged Material Disposal Plan.

Common features of the two implementation components include:

- New disposal sites to accommodate continuing channel maintenance dredging (primarily in Oklahoma), and

- Construction of additional river training structures to facilitate the maintenance of the navigation channel (primarily in Arkansas).

Components 2 and 3 were carried forward for detailed evaluation. Since no new actions are proposed under Component 3, it is evaluated as the No Action component of the decision alternatives described in section ES.4.4.

ES.4.2 River Flow Management Feature

Optimum river flows are defined as less than 60,000 cubic feet per second (cfs) at Van Buren, Arkansas. This definition correlates to optimum conditions for commercial navigation on the MKARNS. Tow sizes must be reduced when flows are above 60,000 cfs. Van Buren is the critical control point in the system because it is the most downstream regulation station for the MKARNS. That is, all the upstream releases are adjusted based on what is happening at the Van Buren Gage. MKARNS navigation traffic normally ceases when flows reach 100,000 cfs at Van Buren, Arkansas. The proposed River Flow Management Action is to improve the safety and efficiency of commercial navigation operations by managing the MKARNS to limit periods of sustained high flows. This could be achieved by reducing the number of days when river flows exceed 100,000 cfs and re

ducing the number of days when the river exceeds 60,000 cfs at Van Buren. In addition, other authorized project purposes, including flood control, recreation; hydropower; water supply; and fish and wildlife would be maintained.

The components screening process included the evaluation of a range of river flow management components to determine which were the most viable and would be considered for implementation. Twenty-three river flow management components were compared using the USACE SUPER (Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System) Model in the evaluation process. The SUPER Model program was run for each of the initial components. During the review process many factors were considered including flood control, fish and wildlife, recreation, hydroelectric power, water quality, and river navigation. Based upon the review process, four components were selected for detailed analysis. These include the No Action Component as well as three viable implementation components.

- Component 1: No Action Component - This component would continue the existing operational plan.

- Component 2: 175,000 cfs Component - The 175,000 cfs Component is described as: Van Buren controlled to 175,000 cfs and Sallisaw to 175,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3% except from June 15 – October 1.

- Component 3: 200,000 cfs Component - The 200,000 cfs Component is described as: Van Buren controlled to 200,000 cfs and Sallisaw controlled to 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3% except from June 15 – October 1. By slowing releases from flood storage, this component would marginally increase the risk of exceeding capacity behind the dams in the event of repetitive high water rains.

- Component 4: Operations Only Component - The Operations Only Component entails modifying the current operations plan to better meet the objectives of the proposed action.

The Operations Only Component is defined as the existing plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 - October 1. The Operations Only Component is defined as the existing plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 - October 1.

ES.4.3 Navigation Channel Deepening Feature

Navigation channel depth limits the potential efficiency and volume of commercial navigation operations on the MKARNS. The Navigation Channel Deepening Action is to deepen the navigation channel in the MKARNS to allow deeper draft tows to operate on the system. This incorporates the potential for establishing a consistent navigation channel width throughout the entire MKARNS. In addition, other authorized MKARNS project purposes, including flood control, recreation, hydropower, water supply, and fish and wildlife would be maintained.

The screening process included the evaluation of a range of components to determine which are viable to be considered for implementation, including dredging the channel, and raising the pool elevations on the river. Raising the pool elevations had the potential to incur high costs and cause flooding. The cost of having to purchase a flowage easement would be substantial and landowners along the waterway have continually expressed concerns about impact of river flows on their properties. Therefore, any alternatives involving raising the pool elevations were considered not practical or economically justified. Based upon the review process, viable components were selected for detailed analysis. These include the No Action Component as well as a variety of navigation channel dredging components that incorporate multiple navigation channel depths and river segments.

This component set explores the options of deepening the navigation channel to 10, 11 or 12 feet versus no action. To better assess the navigation channel deepening components, the MKARNS was divided into six river segments, from the mouth of the MKARNS at the Mississippi River to the Port of Catoosa in Oklahoma. The six segments were divided as follows: Mouth to Pine Bluff (NM 0-75.2), Pine Bluff to Little Rock (NM 75.2-119.5), Little Rock to Dardanelle (NM 119.5-220.3), Dardanelle to Fort Smith(NM 220.3-308.7), Fort Smith to Muskogee (NM308.7-394.0) and Muskogee to Catoosa (NM 394.0-445.2). This breakdown makes analysis of the action comprehensive and flexible by providing the option of deepening the navigation channel only up to a certain segment on the system or the entire river, as appropriate.

The two elements of the navigation channel deepening feature are:

- Navigation channel deepening via dredging and the disposal of dredged materials, and
- Construction of additional river training structures to facilitate the maintenance of the deeper navigation channel.

The three action components for navigation channel deepening (10-foot, 11-foot, and 12-foot) are similar in nature in that all three would include deepening of the navigation channel. The three components vary in the amount of material dredged and disposed of as well as the length of

any necessary new or modified river training structures. The 10-foot component was eliminated early in the evaluation process since it had a benefit cost ratio well below (0.56) 1.0.

ES.4.4 Alternatives

Decision Alternatives were developed based upon the analyses of the features and components. Alternatives, including the No Action Alternative, were developed by combining components of the three features to achieve, in varying degrees, the proposed action. Table ES-2 summarizes the components used in the five alternatives selected for evaluation. A detailed explanation of why components were selected for inclusion in the five alternatives selected is given in section ES.5.1 of this document.

Table ES-1. Components of Decision Alternatives

	Navigation Channel Maintenance	Flow Management Operations Only	Navigation Channel Deepening 11 Ft.	Navigation Channel Deepening 12 Ft.
Alternative A No Action	X			
Alternative B Maintenance Only	X			
Alternative C Maintenance & Ops Only Flow Management	X	X		
Alternative D Maintenance & Ops Only Flow Management & 11 Foot Navigation Channel	X	X	X	
Alternative E Maintenance & Ops Only Flow Management & 12 Foot Navigation Channel	X	X		X

* Navigation channel maintenance activities would occur in the same manner under Alternatives B, C, D, and E. The navigation channel depth to be maintained would be 9-feet for Alternatives B and C, 11-feet for Alternative D, and 12-feet for Alternative E.
Source: USACE 2005

Alternative A - No Action. The No Action Alternative consists of maintaining the current MKARNS Operation System. No changes in existing river or reservoir operations would be made. The existing flow management plan would remain unchanged, the existing depth of the navigation channel would remain unchanged, and the existing navigation channel maintenance activities would remain unchanged. Dredged material would continue to be disposed of at existing sites until they reach their holding capacity. The USACE would utilize existing approved disposal sites, and no new dredged material disposal sites will be developed.

Alternative B – Navigation Channel Maintenance Only. Alternative B consists of adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity, which will reach capacity at some locations along the MKARNS in the near future. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term Dredged Material

Disposal Plan (DMDP). The existing flow management plan would remain unchanged and the existing depth of the navigation channel would remain unchanged.

Alternative C - Navigation Channel Maintenance and Operations Only Flow Management. Alternative C consists of adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity, which will reach capacity at some locations along the MKARNS in the near future and replacing the existing flow management plan with the Operations Only Flow Management Plan. The existing depth of the navigation channel would remain unchanged.

Alternative D - Navigation Channel Maintenance, Operations Only Flow Management, and 11 Foot Navigation Channel. Alternative D consists of 1) adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity which will reach capacity at some locations along the MKARNS in the near future, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 11 feet.

Alternative E - Navigation Channel Maintenance, Operations Only Flow Management, and 12 Foot Navigation Channel. Alternative E consists of 1) adding new dredged material disposal sites in Oklahoma to supplement current disposal site capacity which will reach capacity at some locations along the MKARNS in the near future, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 12 feet.

ES.5 ENVIRONMENTAL CONSEQUENCES

The environmental consequences associated with the proposed action were evaluated in a two step process.

- First the environmental consequences associated with the three features and their respective components were evaluated. This assessment was conducted based on evaluating the impacts associated with each feature independent of the other features (see Chapter 5).
- The second step involved the evaluation of impacts associated with alternatives. Based on the results of the features and components evaluations, in combination with economic information developed in the Feasibility Study, a series of decision alternatives were developed. These alternatives include combinations of components from the three project features that achieve, in varying degrees, the proposed action of the study. This analysis evaluated the environmental consequences of combined components (see Chapters 6, 7, and 8).

ES.5.1 Features and Components

Analysis of the components within each feature was undertaken. Environmental consequences of the components were based on evaluating the impacts associated with each feature independent of the other features. Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts, some components were carried forward as a part of the decision alternatives analyses (see Chapter 5).

- **Navigation Channel Depth Maintenance Features and Components.** Two action components were evaluated in detail. The Maintenance Dredged Material Disposal in New Disposal Sites Component was clearly the most favorable component among the Navigation Channel Depth Maintenance Features. This component attained the proposed action while having fewer adverse environmental impacts compared to the other component evaluated. Consequently, this is the only component of the Navigation Channel Maintenance Features that was carried forward as a part of the decision alternatives analyses.
- **Flow Management Features and Components.** Three action components were evaluated in detail. The Operations Only Component was clearly the most favorable component among the Flow Management Features. Only this component attained the proposed action while achieving a positive cost benefit ratio and with minimal adverse environmental impacts. Consequently, this is the only component of the Flow Management Features that was carried forward as a part of the decision alternatives analyses.
- **Navigation Channel Deepening Features and Components.** Several channel deepening components were evaluated in detail from the channel deepening feature. These components included increased channel depths (10, 11, and 12 feet) within six river segments along the entire MKARNS. The following summarizes the findings:

    - Economic benefits of deepening the navigation channel are achieved primarily by deepening the entire system and not portions of the system. Approximately two thirds of the benefits are realized in the uppermost reach, reach 6. Incremental deepening of the navigation channel on only lower portions of the MKARNS is not economically justified.
    - Deepening the navigation channel to 10 or 11 feet is not economically justified since these cost benefit ratios are 0.51 and 0.99, or below 1.0.
    - Deepening the navigation channel to 11 feet, although not economically justified, is so close to being economically justified and within the margina depth of error for feasibility analyses that this component 11 feet achieves the proposed action and has no significant adverse impacts. However, strictly interpreted this component is not economically justified because it has a benefit cost ratio of 0.99. Due to the limits of precise forecasting of feasibility level costs and benefit calculations, it was assumed that this component of the navigation channel deepening features should be carried forward and would be included in the alternatives analyses.
    - Deepening the navigation channel to a depth of 12 feet achieves the purpose, is economically justified with a positive cost benefit ratio, and there are no significant adverse impacts associated with this component. Consequently, this component is carried forward in the alternatives analyses

ES.5.2 Environmental Consequences of Alternatives

Five alternatives were evaluated. These alternatives include combinations of components from the three project features that achieve, in varying degrees, the proposed action of the study. The analysis evaluated the environmental consequences of combined components (see Chapters 6, 7, and 8).

In general the impacts associated with the alternatives are directly associated with the extent of the habitat loss/disturbance anticipated with the implementation of each alternative. Anticipated environmental impacts are progressively higher, with Alternative A exhibiting the lowest level of

adverse impacts and Alternative E the highest level of adverse impacts. Therefore, Alternative A is considered the Environmentally Preferred Alternative.

Impacts associated with Alternatives A and B are similar in that these alternatives are limited to channel maintenance activities only.

The impacts associated with Alternative C are also similar to those associated with Alternatives A and B in that flow management changes will be incorporated along with channel maintenance activities. Flow management changes are expected to have minimal adverse impacts on the MKARNS.

Adverse impacts are expected to be highest for Alternatives D and E which include the deepening of the navigation channel in addition to channel maintenance activities and flow management changes. The impacts associated with implementing Alternatives D and E are similar in nature with the impacts of Alternative E being higher than Alternative D due to the higher volume of dredging and disposal associated with this alternative.

Table ES-3 shows a summary of the environmental consequences.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Air Quality	**No Impact**	**No Impact**	**No Impact**	**No Impact**	**No Impact**
	No change from existing conditions.	No change from existing conditions.	No change from existing conditions.	No change from existing conditions.	No change from existing conditions.
Noise	**No Impact**	**No Impact**	**No Impact**	**Minor Adverse**	**Minor Adverse**
	No change from existing conditions.	No change from existing conditions.	No change from existing conditions.	Short-term impacts from additional noise from dredge deepening operations.	Short-term impact from additional noise from dredge deepening operations.
Geology and Soils	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	Long-term impact due to continued erosion and compaction of soils at dredge material disposal sites.	Long-term impact due to continued erosion and compaction of soils at existing and new dredge material disposal sites.	Long-term impact due to continued erosion and compaction of soils at existing and new dredge material disposal sites. Additional minor impacts associated with a very slight increase in agriculture production and potential pesticide use.	Long-term minor impact associated with an increase in agricultural production and pesticide use.	Long-term minor impact associated with an increase in agricultural production and pesticide use.
	-	-	-	**Minor Adverse**	**Minor Adverse**
	-	-	-	Short-term increase in sediment suspension, movement, and resettlement caused by dredging.	Slightly more short-term increases in sediment suspension, movement, and resettlement caused by dredging. due to a greater dredge volume in Alternative E than in Alternative D.
	-	-	-	**Minor Adverse**	**Minor Adverse**
	-	-	-	Increase in barge traffic and sediment suspension on the MKARNS after completion of dredging.	Increase in barge traffic and sediment suspension on the MKARNS after completion of dredging.

Table ES-2. Summary of Environmental Consequences					
	Alternative A **No Action**	**Alternative B** **Maintenance Only**	**Alternative C** **Maintenance & Ops Only Flow Management**	**Alternative D** **Maintenance & Ops Only Flow Management & 11 Ft Nav Channel**	**Alternative E** **Maintenance & Ops Only Flow Management & 12 Ft Nav Channel**
Geology and Soils	-	-	-	**Minor Adverse**	**Minor Adverse**
	-	-	-	Short-term impact associated with soil erosion and compaction at new dredge disposal sites.	Short-term impact associated with soil erosion and compaction at new dredge disposal sites.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Surface Water	**No Impact**	**No Impact**	**No Impact**	**No Impact**	**No Impact**
	No change from existing conditions. A Tier II analysis would be required for continued or new disposal of material from potentially contaminated sediment from selected sites.	No change from existing conditions. A Tier II analysis would be required for continued or new disposal of material from potentially contaminated sediment from selected sites.	No change from existing conditions. A Tier II analysis would be required for continued or new disposal of material from potentially contaminated sediment from selected sites.	No change from existing conditions. A Tier II analysis would be required for continued or new disposal of material from potentially contaminated sediment from selected sites.	No change from existing conditions. A Tier II analysis would be required for continued or new disposal of material from potentially contaminated sediment from selected sites.
	-	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	-	Short-term increased levels of suspended sediment during construction and modification of river training structures.	Short-term increased levels of suspended sediment during construction and modification of river training structures.	Short-term increased levels of suspended sediment during construction and modification of river training structures, but at a higher level than Alternative C given the increased number of river training structures and revetments.	Short-term increased levels of suspended sediment during construction and modification of river training structures, but at a higher level than Alternative C and D given the increased number of river training structures and revetments.
	-	-	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	-	-	Long-term reservoir storage level changes may lead to increased inundation of vegetated areas that could provide additional habitat for larval fish and organic material for primary consumers.	Long-term reservoir storage level changes may lead to increased inundation of vegetated areas that could provide additional habitat for larval fish and organic material for primary consumers.	Long-term reservoir storage level changes may lead to increased inundation of vegetated areas that could provide additional habitat for larval fish and organic material for primary consumers.
	-	-		**Minor Adverse**	**Minor Adverse**
	-	-		Increased sediment suspension resulting from increased dredging and navigational traffic. In Arkansas, all water quality certification procedures will be adhered to for both terrestrial and aquatic dredge disposal sites. BMPs that would be implemented by USACE for open water dredge disposal would include using floating silt curtains at all disposal sites, dredging during low flow periods, and avoiding disposal in valuable aquatic areas such as the entrances to tributary streams and oxbow lakes.	Increased sediment suspension resulting from increased dredging and navigational traffic, but at a higher degree than Alternative D given the increased volume of dredged material. In Arkansas, all water quality certification procedures will be adhered to for both terrestrial and aquatic dredge disposal sites. BMPs that would be implemented by USACE for open water dredge disposal would include using floating silt curtains at all disposal sites, dredging during low flow periods, and avoiding disposal in valuable aquatic areas such as the entrances to tributary streams and oxbow lakes.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Land Use	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	Continued saturation and ponding of farmland soils.	Conversion of 734 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS for use as dredge material disposal sites**.**	Conversion of 734 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS for use as dredge material disposal sites.	Conversion of 5,132 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS for use as dredge material disposal sites.	Conversion of 5,132 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS for use as dredge material disposal sites.
	-	**Minor Adverse**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
	-	Continued saturation and ponding of farmland soils.	Decrease in inundation would have a minor beneficial impact on cropland.	Decrease in inundation would have a minor beneficial impact on cropland.	Decrease in inundation would have a minor beneficial impact on cropland.
	-	**Minor Adverse Cumulative**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	-	Conversion of additional land for dredge disposal sites in addition to other current and reasonably foreseeable future land conversions..	Long term adverse impact to native vegetation as a decrease in inundation may encourage the additional cropping of land.	Long term adverse impact to native vegetation as less inundation may encourage the additional cropping of land. Increased navigation may encourage the development of additional ports and marinas which would result in a minor loss of farmland, open areas, or a conversion of one developed land use to another.	Long term adverse impact to native vegetation as less inundation may encourage the additional cropping of land. A proportionately larger increase in the conversion of land associated with greater navigational efficiency.
	-	-	**Minor Adverse Cumulative**	**Minor Adverse Cumulative**	**Minor Adverse Cumulative**
	-	-	Conversion of additional land for dredge disposal sites in addition to other current and reasonably foreseeable future land conversions.	Conversion of additional land for dredge disposal sites in addition to other current and reasonably foreseeable future land conversions.	Conversion of additional land for dredge disposal sites in addition to other current and reasonably foreseeable future land conversions.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Infrastructure	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	Long-term continuation of high flow rates would continue to restrict barge traffic.	Long-term continuation of high flow rates would continue to restrict barge traffic.	Sustained maintenance dredging would continue with the construction of 2 new and 50 modified river training structures and 2 new and 4 modified revetments.	Dredging to a depth of 11 feet and maintenance of the channel would require 91 new and 137 modified river training structures and 3 new and 20 modified revetments. This would be an approximate 7% increase in the number of river training structures and an approximate 1% increase in the number of revetments along the MKARNS.	Dredging to a depth of 12 feet and maintenance of the channel would require 91 new and 137 modified river training structures and 3 new and 20 modified revetments. This would be an approximate 7% increase in the number of river training structures and an approximate 1% increase in the number of revetments along the MKARNS.
	Minor Adverse	**Minor Adverse**	**Minor Beneficial**	**Major Beneficial**	**Major Beneficial**
	Long-term restriction in power generation would continue.	Long-term restriction in power generation would continue.	Reduction of flow above 61,000 cfs would benefit the efficiency and reliability of commercial navigation and would reduce the impact on levees, locks and dams, and other in-river structures**.**	Channel deepening and reduction of flow above 61,000 cfs would benefit the efficiency and reliability of commercial navigation and would reduce the impact on levees, locks and dams, and other in-river structures.	Channel deepening and reduction of flow above 61,000 cfs would l benefit the efficiency and reliability of commercial navigation and would reduce the impact on levees, locks and dams, and other in-river structures.
	Minor Adverse Cumulative	**Minor Adverse**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
	Increased truck traffic in response to economic growth and lack of navigation increases	Sustained maintenance dredging would continue with the construction of 2 new and 50 modified river training structures and 2 new and 4 modified revetments.	Total monetary hydropower benefits resulting from flow changes would increase by $466,000.	Total monetary hydropower benefits resulting from flow changes would increase by $466,000.	Total monetary hydropower benefits resulting from flow changes would increase by $466,000.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Infrastructure	-	-	**Minor Adverse**	-	-
	-	-	Economic growth would indirectly stimulate higher traffic levels, which would require more roadway maintenance, repair, and may result in additional road construction.	-	-
	-		**Minor Beneficial Cumulative**	**Minor Beneficial Cumulative**	**Minor Beneficial Cumulative**
	-		Benefits to the navigation industry could lower transportation costs for the region. Hydroelectric power generation would also benefit under the proposed action. These benefits, when combined with benefits obtained from reasonably foreseeable future projects, would create a minor beneficial cumulative impact.	Benefits to the navigation industry could lower transportation costs for the region. Hydroelectric power generation would also benefit under the proposed action. These benefits, when combined with benefits obtained from reasonably foreseeable future projects, would create a minor beneficial cumulative impact.	Benefits to the navigation industry could lower transportation costs for the region. Hydroelectric power generation would also benefit under the proposed action. These benefits, when combined with benefits obtained from reasonably foreseeable future projects, would create a minor beneficial cumulative impact.
Biological Resources					
T & E Species	**Minor Adverse**	**No Impact**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
	Dredge disposal may occur on currently inactive sites. This disposal could potentially have adverse impacts to bald eagle and American burying beetle habitat. However, the impacts should be minor if the protective measures recommended by the USFW are implemented. Despite the protective measures, some American burying beetles may be disturbed or killed during the ground disturbing activities, but the effects are expected to be infrequent and of short duration.	BMPs and RPMs identified in the BO would be incorporated. The BO is included in Appendix C. Implementation of the BMPs and RMPs would also not impact the ivory-billed woodpecker.	An average 5 day decrease in flow during nesting periods would enhance Least Tern nesting success as flooding of sandbars and islands used for nesting would be reduced. BMPs and RPMs identified in the BO would be incorporated. The BO is included in Appendix C. Implementation of the BMPs and RMPs would not impact the ivory-billed woodpecker.	An average 5 day decrease in flow during nesting periods would enhance Least Tern nesting success as flooding of sandbars and islands used for nesting would be reduced. BMPs and RPMs identified in the BO would be incorporated. The BO is included in Appendix C. Additional benefits to the least tern associated with the creation of additional habitat areas on dredge disposal sites.	An average 5 day decrease in flow during nesting periods would enhance Least Tern nesting success as flooding of sandbars and islands used for nesting would be reduced. BMPs and RPMs identified in the BO would be incorporated. The BO is included in Appendix C Additional benefits to the least tern associated with the creation of additional habitat areas on dredge disposal sites.

Table ES-2. Summary of Environmental Consequences					
	Alternative A **No Action**	**Alternative B** **Maintenance Only**	**Alternative C** **Maintenance & Ops Only Flow Management**	**Alternative D** **Maintenance & Ops Only Flow Management & 11 Ft Nav Channel**	**Alternative E** **Maintenance & Ops Only Flow Management & 12 Ft Nav Channel**
T & E Species	-	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	-	Conversion of terrestrial habitat for dredge disposal sites may disturb or kill American burying beetles during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration. Implementation of the BMPs and RMPs, and dredge disposal activities would not impact the ivory-billed woodpecker.	Conversion of terrestrial habitat for dredge disposal sites may disturb or kill American burying beetles during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration. Implementation of the BMPs and RMPs, and dredge disposal activities would not impact the ivory-billed woodpecker.	Conversion of terrestrial habitat for dredge disposal sites may disturb or kill American burying beetles during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration. Implementation of the BMPs and RMPs, and dredge disposal activities would not impact the ivory-billed woodpecker.	Conversion of terrestrial habitat for dredge disposal sites may disturb or kill American burying beetles during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration. Implementation of the BMPs and RMPs, and dredge disposal activities would not impact the ivory-billed woodpecker.
Wetlands	**Minor Adverse** Inactive sites that may contain wetlands may be used for dredged material disposal. Before disposal occurs, jurisdictional wetland determinations would be conducted and appropriate mitigation would be carried out.	**No Impact**	**No Impact** The changes in river flows that may influence wetlands are very minor and are documented in Tables 5-2 and 5-3.	**No Impact** The changes in river flows that may influence wetlands are very minor and are documented in Tables 5-2 and 5-3. Although the projected volume of dredged material is different between Alt. D and E, the assumption was made that all disposal sites would be used and that all disposal sites would be completely impacted with implementation of either Alt D or Alt E (Table 6-2).	**No Impact** The changes in river flows that may influence wetlands are very minor and are documented in Tables 5-2 and 5-3. Although the projected volume of dredged material is different between Alt. D and E, the assumption was made that all disposal sites would be used and that all disposal sites would be completely impacted with implementation of either Alt D or Alt E (Table 6-2). The same area of land would be covered to a greater depth under Alt E.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Aquatic Resources	**No Impact**	**Minor Adverse**	**Minor Adverse**	**Major Adverse**	**Major Adverse**
	-	The potential loss of 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (existing pre-approved maintenance dredged material disposal sites). Additional dredge disposal sites would impact 165 acres of aquatic habitat and construction and modification of river training structures and revetments would have a minor impact on aquatic life.	The potential loss of 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (existing pre-approved maintenance dredged material disposal sites). Additional dredge disposal sites would impact 165 acres of aquatic habitat and construction and modification of river training structures and revetments would have a minor impact on aquatic life.	The potential loss of 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (existing pre-approved maintenance dredged material disposal sites). Other potential impacts to aquatic resources include the conversion of approximately 165 acres of aquatic habitat for maintenance dredging, 3,126 acres of aquatic habitat in Arkansas for deepening, and 345 acres of aquatic habitat in Arkansas and Oklahoma for deepening for a total of 6,120 acres of aquatic habitat throughout the MKARNS. High quality habitat would be avoided which minimizes this impact, however, given the increase in acreage over Alternatives A-C, the magnitude of impact is rated higher.	The potential loss of 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (existing pre-approved maintenance dredged material disposal sites). Other potential impacts to aquatic resources include the conversion of approximately 165 acres of aquatic habitat for maintenance dredging, 3,126 acres of aquatic habitat in Arkansas for deepening, and 345 acres of aquatic habitat in Arkansas and Oklahoma for deepening for a total of 6,120 acres of aquatic habitat throughout the MKARNS. High quality habitat would be avoided which minimizes this impact, however, given the increase in acreage over Alternatives A-C, the magnitude of impact is rated higher.
	-	-	-	**Major Adverse**	**Major Adverse**
	-	-	-	Deepening the channel may impact mussel communities. Prior dredging and deepening has degraded the existing substrate.	Deepening the channel may impact mussel communities. Prior dredging and deepening has degraded the existing substrate.
Aquatic Resources	-	-	-	**Major Adverse**	**Major Adverse**
	-	-	-	Approximately 4,809 acres and of navigation channel substrate would be dredged for deepening and approximately 1,429 acres of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 6,238 acres.	Approximately 5,645 acres of navigation channel substrate would be dredged for deepening and approximately 1,429 acres of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 7,074 acres.
	-	-	-	**Minor Adverse**	**Minor Adverse**
	-	-	-	Approximately 165 acres of gravel habitat and 628 acres of sand/gravel habitat would be impacted by the dredging associated with this alternative. Impacts to gravel habitat would be short-term.	Approximately 165 acres of gravel habitat and 628 acres of sand/gravel habitat would be impacted by the dredging associated with this alternative. Impacts to gravel habitat would be short-term.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Terrestrial Resources	**Major Adverse**	**Minor Adverse**	**Minor Adverse**	**Major Adverse**	**Major Adverse**
	Long term use of inactive terrestrial dredge disposal sites identified and approved in the 1974 EIS and/or in existing sites in Arkansas until those locations reached capacity. Many of the terrestrial sites approved in the 1974 EIS have not been utilized since creation of the navigation channel and contain mature vegetation. Use of these sites would require site reworking and additional mitigation.	Additional dredge disposal sites would impact approximately 569 acres of terrestrial habitat.	Additional dredge disposal sites would impact approximately 569 acres of terrestrial habitat.	Potential impacts terrestrial resources from maintenance and deepening dredging include a conversion of approximately 1,496 acres to dredged material disposal sites along the MKARNS. These sites are generally not areas of high quality habitat. However, given the increase in acreage over Alternatives A-C, the magnitude of impact is rated higher.	Potential impacts terrestrial resources from maintenance and deepening dredging include a conversion of approximately 1496 acres to dredged material disposal sites along the MKARNS. These sites are generally areas of degraded habitat. However, given the increase in acreage over Alternatives A-D, the magnitude of impact is rated higher.
	Minor Adverse Cumulative	**Minor Adverse Cumulative**	**Minor Adverse Cumulative**	**Minor Adverse Cumulative**	**Minor Adverse Cumulative**
	Terrestrial habitats may be influenced by cumulative changes within the study area. Minor adverse impacts associated with continued population growth may result in the encroachment into terrestrial habitats	Loss of terrestrial habitat, when combined with impacts to terrestrial habitat associated with population growth in the project area, could have a cumulative impact on terrestrial habitat. Since the majority of area impacted would not be high quality habitat, such as agricultural lands and old field, cumulative impacts to biological resources would be minor.	Loss of terrestrial habitat, when combined with impacts to terrestrial habitat associated with population growth in the project area, could have a cumulative impact on terrestrial habitat. Since the majority of area impacted would not be high quality habitat, such as agricultural lands and old field, cumulative impacts to biological resources would be minor.	Loss of terrestrial habitat, when combined with impacts to terrestrial habitat associated with population growth in the project area, could have a cumulative impact on terrestrial habitat. Since the majority of area impacted would not be high quality habitat, such as agricultural lands and old field, cumulative impacts to biological resources would be minor.	Loss of terrestrial habitat, when combined with impacts to terrestrial habitat associated with population growth in the project area, could have a cumulative impact on terrestrial habitat. Since the majority of area impacted would not be high quality habitat, such as agricultural lands and old field, cumulative impacts to biological resources would be minor.
Recreation and Aesthetic Values	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	Short-term impact to recreational resources may occur during dredging when some areas are not completely accessible.	Short-term impact to recreational resources may occur during dredging when some areas are not completely accessible. Short-term impact to visual resources during construction of river training sources.	Short-term impact to recreational resources may occur during dredging when some areas are not completely accessible. Short-term impact to visual resources during construction of river training sources.	Short-term impact to recreational resources may occur during dredging when some areas are not completely accessible. Short-term impact to visual resources during construction of river training sources. Greater impacts than Alternatives B and C due to additional river training structures and revetments.	Short-term impact to recreational resources may occur during dredging when some areas are not completely accessible. Short-term impact to visual resources during construction of river training sources. Greater impacts than Alternatives B and C due to additional river training structures and revetments. Also greater impacts than Alternative D due to increased dredging and volumes.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
	-		**Minor Beneficial**	**Minor Adverse**	**Minor Adverse**
	-		An annual average of two fewer days of flow above 75,000 cfs at Van Buren would enhance the safety of pleasure boaters and fisherman.	Loss of recreational opportunities as a result of the creation of dredge material disposal sites.	Loss of recreational opportunities as a result of the creation of dredge material disposal sites.
	-	-	-	**Minor Beneficial**	**Minor Beneficial**
	-	-	-	An annual average of two fewer days of flow above 75,000 cfs at Van Buren would enhance the safety of pleasure boaters and fisherman.	An annual average of two fewer days of flow above 75,000 cfs at Van Buren would enhance the safety of pleasure boaters and fisherman.
Cultural Resources	**No Impact**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
		Potential impacts resulting from physical disturbance from construction and/or modification of dikes and revetments within the river channel and adjacent shoreline. Use of new disposal locations and vandalism from temporarily increased access during construction of shoreline revetments. Potential audio intrusions on architectural resources during construction.	Potential impacts resulting from physical disturbance from construction and/or modification of dikes and revetments within the river channel and adjacent shoreline. Use of new disposal locations and vandalism from temporarily increased access during construction of shoreline revetments. Potential audio intrusions on architectural resources during construction.	Potential impacts resulting from physical disturbance from construction and/or modification of dikes and revetments within the river channel and adjacent shoreline. Impacts would be on a greater scale than Alternatives B and C as the number of structures is increased**.** Use of new disposal locations and vandalism from temporarily increased access during construction of shoreline revetments. Potential audio intrusions on architectural resources during construction.	Potential impacts resulting from physical disturbance from construction and/or modification of dikes and revetments within the river channel and adjacent shoreline. Impacts would be on a greater scale than Alternatives B, C, and D as the number of structures is increased**.** Use of new disposal locations and vandalism from temporarily increased access during construction of shoreline revetments. Potential audio intrusions on architectural resources during construction.
	-	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
	-	Impacts at new dredge disposal sites associated with ground preparation and burial of potential NRHP eligible sites. Potential visual intrusions on architectural resources at dredge material disposal locations.	Impacts to archaeological sites as a result of changes to river flow and reservoir elevation may include physical disturbance through wave action, erosion of archaeological sites located along the shoreline, undercutting, slumping and subsequent erosion of shoreline archaeological sites, and vandalism of archaeological materials from temporarily increased access to sites during periods of low water flow. Impacts to architectural resources include damage or destruction by erosion and flooding, and audio or visual intrusions to associated historic settings or cultural landscapes or alterations to viewsheds that form the cultural landscapes at these resources.	Proposed locations of river bottom dredging may affect submerged archaeological sites. And has the potential to affect documented shipwreck sites on the MKARNS. Impacts to archaeological sites as a result of changes to river flow and reservoir elevation may include physical disturbance through wave action, erosion of archaeological sites located along the shoreline, undercutting, slumping and subsequent erosion of shoreline archaeological sites, and vandalism of archaeological materials from temporarily increased access to sites during periods of low water flow. Impacts to architectural resources include damage or destruction by erosion and flooding, and audio or visual intrusions to associated historic settings or cultural landscapes or alterations to viewsheds that form the cultural landscapes at these resources.	Proposed locations of river bottom dredging may affect submerged archaeological sites. And has the potential to affect documented shipwreck sites on the MKARNS. Impacts to archaeological sites as a result of changes to river flow and reservoir elevation may include physical disturbance through wave action, erosion of archaeological sites located along the shoreline, undercutting, slumping and subsequent erosion of shoreline archaeological sites, and vandalism of archaeological materials from temporarily increased access to sites during periods of low water flow. Impacts to architectural resources include damage or destruction by erosion and flooding, and audio or visual intrusions to associated historic settings or cultural landscapes or alterations to viewsheds that form the cultural landscapes at these resources.

Table ES-2. Summary of Environmental Consequences					
	Alternative A **No Action**	**Alternative B** **Maintenance Only**	**Alternative C** **Maintenance & Ops Only Flow Management**	**Alternative D** **Maintenance & Ops Only Flow Management & 11 Ft Nav Channel**	**Alternative E** **Maintenance & Ops Only Flow Management & 12 Ft Nav Channel**
Cultural Resources	**Minor Cumulative Adverse**	**Minor Cumulative Adverse**	**Minor Cumulative Adverse**	**Minor Cumulative Adverse**	**Minor Cumulative Adverse**
	Cumulative impacts would result from continued use and development of the river floodplain for commercial, industrial, residential and agricultural uses. Cumulative effects would include physical disturbance of terrestrial and submerged cultural and archaeological resources through ongoing future construction of pipeline crossings, utility corridor crossings, and construction of piers for bridges. A list of reasonably foreseeable future actions is provided in section 7.1.3.	Cumulative impacts would result from continued use and development of the river floodplain for commercial, industrial, residential and agricultural uses. Cumulative effects would include physical disturbance of terrestrial and submerged cultural and archaeological resources through ongoing future construction of pipeline crossings, utility corridor crossings, and construction of piers for bridges A list of reasonably foreseeable future actions is provided in section 7.1.3. .	Cumulative impacts would result from continued use and development of the river floodplain for commercial, industrial, residential and agricultural uses. Cumulative effects would include physical disturbance of terrestrial and submerged cultural and archaeological resources through ongoing future construction of pipeline crossings, utility corridor crossings, and construction of piers for bridges A list of reasonably foreseeable future actions is provided in section 7.1.3. .	Cumulative impacts would result from continued use and development of the river floodplain for commercial, industrial, residential and agricultural uses. Cumulative effects would include physical disturbance of terrestrial and submerged cultural and archaeological resources through ongoing future construction of pipeline crossings, utility corridor crossings, and construction of piers for bridges. Physical disturbance of terrestrial and submerged cultural resources in addition to the baseline levels associated with reasonably foreseeable future actions, but to a greater extent given the increase in depth. A list of reasonably foreseeable future actions is provided in section 7.1.3.	Cumulative impacts would result from continued use and development of the river floodplain for commercial, industrial, residential and agricultural uses. Cumulative effects would include physical disturbance of terrestrial and submerged cultural and archaeological resources through ongoing future construction of pipeline crossings, utility corridor crossings, and construction of piers for bridges. Physical disturbance of terrestrial and submerged cultural resources in addition to the baseline levels associated with reasonably foreseeable future actions, but to a greater extent given the increase in depth. A list of reasonably foreseeable future actions is provided in section 7.1.3.

Table ES-2. Summary of Environmental Consequences

	Alternative A No Action	Alternative B Maintenance Only	Alternative C Maintenance & Ops Only Flow Management	Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel
Sociological Resources	**No Impact**	**Minor Adverse**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
	-	-	Changes in river flow would increase the efficiency of barge traffic thereby adding to an increase in employment in the industry. Farm fields would be flooded less frequently benefiting agricultural production and quality of life.	Changes in river flow would increase the efficiency of barge traffic thereby adding to an increase in employment in the industry. Farm fields would be flooded less frequently benefiting agricultural production and quality of life.	Changes in river flow would increase the efficiency of barge traffic thereby adding to an increase in employment in the industry. Farm fields would be flooded less frequently benefiting agricultural production and quality of life.
	-	-	-	**Minor Adverse**	**Minor Adverse**
	-	-	-	Dredging operations and dredge material disposal would require one residential displacement and relocation.	Dredging operations and dredge material disposal would require one residential displacement and relocation.
Economic Resources	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	Continuation of the current condition of navigation days and navigation efficiencies would not result in a benefit to the navigation industry that would occur under the other alternatives.	Some productive cropland would be acquired for dredge disposal sites resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues.	Some productive cropland would be acquired for dredge disposal sites resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues.	Some productive cropland would be acquired for dredge disposal sites resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues.	Some productive cropland would be acquired for dredge disposal sites resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues.
	-	-	**Major Beneficial**	**Major Beneficial**	**Major Beneficial**
	-	-	Annual positive net benefits of $8.8 million.	The benefit-to-cost ratio of 1.9 results in annual positive incremental net benefits of approximately $8.8 million.	The benefit-to-cost ratio of 1.8 results in annual positive incremental net benefits of approximately $9.8 million.
		-	-	**Minor Beneficial**	**Minor Beneficial**
		-	-	The differential shipping cost savings per ton is approximately $.64.	The differential shipping costs savings per ton is approximately $1.28.
	-	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**

Table ES-2. Summary of Environmental Consequences					
	Alternative A **No Action**	**Alternative B** **Maintenance Only**	**Alternative C** **Maintenance & Ops Only Flow Management**	**Alternative D** **Maintenance & Ops Only Flow Management & 11 Ft Nav Channel**	**Alternative E** **Maintenance & Ops Only Flow Management & 12 Ft Nav Channel**
	-	Dredging operations would create additional employment, resulting in increased business volume and income for the local economy. In addition, the dredged materials can become a resource as a raw material for various construction and industrial related uses.	Dredging operations would create additional employment, resulting in increased business volume and income for the local economy. In addition, the dredged materials can become a resource as a raw material for various construction and industrial related uses.	Increases in induced traffic on the MKARNS; employment, business volume and income; property tax revenues.	Increases in induced traffic on the MKARNS; employment, business volume and income; property tax revenues.
Economic Resources	-	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**	**Minor Adverse**
	-	Non-agricultural damages and loss of some recreation/tourism benefits.	Non-agricultural damages; loss of some recreational/tourism benefits.	Non-agricultural damages; loss of some recreational/tourism benefits.	Non-agricultural damages; loss of some recreational/tourism benefits**.**

ES.6 Summary of Impacts and Mitigation

Potential environmental impacts are identified by resource category and discussed in detail in Chapter 5, 6, and 7. A summary of impacts are listed in Table ES-3 and are characterized by their relative magnitude as described in Section 5.1. A summary of mitigation measures are found in Chapter 8. The first result of implementation of the proposed mitigation measures is that where possible adverse impacts were avoided or minimized. When avoidance or minimization of impacts was not achievable, adverse impacts to the environment resulting from an action alternative were mitigated through compensation, rectification and reduction. Determination of the required function and value of the impact and mitigation was performed through analytical and quantitative analysis. The final result is that implementation of the mitigation measures will serve to avoid, minimize, reduce, compensate or rectify all potential adverse impacts to the environment if any of the project alternatives are carried out. In addition, to ensure the desired results of the mitigation measures are achieved, a long-term monitoring program is being established and an adaptive management plan was developed to make modifications to measures when necessary to achieve the intended outputs. Mitigation measures will be implemented by the USACE to eliminate or reduce the impact of adverse impacts as defined in 40 CFR 1508.20.

ES.6.1 No Action Alternative

As discussed throughout Chapters 5-7, implementation of the No Action Alternative may result in adverse impacts to the environment. In general these impacts are associated with the routine maintenance of the MKARNS. The USACE would implement the following mitigation measures for adverse impacts associated with the No Action Alternative as they might occur:

- Adhere to all permit conditions associated with MKARNS maintenance activities;
- Continue natural resources management programs including, endangered species management plan provisions, land management, pest control, forest management, and soil erosion control. Continued close coordination with other Federal agencies such as the USFWS and state agencies; and
- Continue the dike notching program, in coordination with USFWS and state agencies, to improve aquatic habitat within the MKARNS.

ES.6.2 Action Alternatives

ES.6.2.1 Biological Resources

Mitigation would be conducted for adverse impacts associated with implementing the proposed action. Mitigation for terrestrial and aquatic impacts would consist of a combination of avoidance, minimization, and compensation. The mitigation has been developed in coordination with the USFWS, Arkansas Game and Fish Commission (AGFC), and the Oklahoma Department of Wildlife and Conservation (ODWC). The terrestrial and the aquatic mitigation

plans also include long term monitoring and adaptive management provisions. Mitigation would be associated with:

- Terrestrial habitat loss associated with the disposal of dredged material;
- Aquatic habitat loss associated with dredging and dredged material disposal;
- Aquatic habitat loss associated with raising and extending dikes and revetments;
- Impacts to mussel beds from dredging and disposal; and
- Impacts to Federal threatened and endangered species.

The Engineer Research and Development Center's Environmental Laboratory (ERDC-EL) used the Habitat Evaluation Procedure (HEP) to evaluate impacts from dredged material disposal and determine mitigation needs for both, terrestrial impacts and aquatic impacts in dike fields. The full HEP analysis used to determine the mitigation needs is described in Appendix C. In HEP, a Habitat Suitability Index (HSI) model is a quantitative estimate of habitat conditions for an evaluation species or community. The HEP is designed to evaluate the future changes in quantity (acres) and quality (habitat suitability and functional capacity) of ecosystems. Outputs are calculated in terms of annualized changes anticipated over the life of the project [i.e., Average Annual Habitat Units (AAHUs)].

It was determined through the terrestrial HEP analysis that 302 acres of forested habitat and 390 acres of grassland habitat would be lost with the use of all potential dredged material disposal sites over the 50-year project life. A total of 130 acres of higher quality bottomland forest habitat and 248 acres of higher quality marsh habitat would mitigate for these lost acres through wetland creation along portions of the MKARNS. Table ES-4 shows these results.

Table ES-3. Summary of Acres, AAHUs, and Annual HSI Lost on Dredged Material Disposal Sites and Gained on Mitigation Sites.

Mitigation Sites Selected: OK408.9L-M, OK405.0 L-M

Cover Type Mitigated For	Sum of Acres Lost	Sum of AAHUs Lost	Average Annual HSI of Acres Lost	Total Acres of Proposed Mitigation Sites Combined	Net Gain in AAHUs from Mitigation Plans	Net HSI Gain	# Acres Needed to Fully Mitigate	Surplus or Shortage of Acres
FOREST (BLHFOREST, UPFOREST)	**-302**	**-83.7**	**0.28**	**130 (NEWBLHFOR)**	**91.0**	**0.70**	**120**	**10**
GRASSLAND (OLDFIELD, OPENFIELD)	**-390**	**-194.0**	**0.50**	**248 (NEWMARSH)**	**187.0**	**0.75**	**258**	**-10**
							Total Surplus or Shortage of Acres:	**0**

Source: ERDC-EL, 2004b

The engineering and HEP analysis for dike field impacts concluded that Pool 2 (NM 19-50) contained the most proposed dredge disposal areas, but due to anticipated higher filling rates, Pools 12 (NM 257-292) and 10 had the greatest aquatic impacts for the Alternative D (66.1 AAHU impacted) and Alternative E (112.6 AAHU impacted) alternatives, respectively. Pool 2 also provided for the most benefits of any one pool with 135.3 AAHU gained with mitigation Alternative D and 104.3 AAHU gained for Alternative E. Pool 14 (NM 319-336) and the Post Canal (NM 19 to White River) contained only proposed mitigation and did not contribute to the overall project impacts. For the entire project (Arkansas and Oklahoma combined), Alternative D would result in a loss of 391 AAHU. However, mitigation for Alternative D would result in a gain of 494 AAHU. Impacts from Alternative E would result in a loss of 664 AAHU while approved mitigation projects equaled 772 AAHU for a net yield of 108 AAHU. Additional impacts for the Verdigris River were identified. To quantify this impact, the number of acres associated with the navigation channel in Verdigris River pools (i.e., 909.1 acres) was multiplied by an HSI of 0.1, indicating low habitat quality for existing conditions, to obtain impacts of 91 AAHU for both alternatives. These additional impacts when compared to the mitigation resulted in a net gain of 403 (494-91) and 17 (108-91) AAHU for Alternatives D and E, respectively.

Incremental and cost effectiveness analysis was performed to facilitate selection of the most productive output measures of the more then 180 identified mitigation features. Two measures were eliminated due to cost effectiveness and an additional five were retained above the mitigation requirement in accordance with the USACE environmental sustainability initiative. This resulted in an overall net gain of 8 AAHU as shown in Table ES-5. The complete Aquatic Evaluation Report and Incremental Cost Analysis are located in Appendix C.

Table ES-4. Summary of Final Dredging and Disposal Impacts and Mitigation

Location	Total Existing AAHUs	AAHUs Impacted by Alt D	Total AAHUs, Alt D, with Mitigation	Change in AAHUs Relative to Baseline, Alt D with Mitigation	AAHUs Impacted by Alt E	Total AAHUs, Alt E, with Mitigation	Change in AAHUs Relative to Baseline, Alt E with Mitigation
Arkansas	3326	-337	3,737	411	-598	3,364	38
Oklahoma	546	-145	538	-8	-157	525	-21
TOTAL	3,872	-482	4,275	403	-755	3,889	17
Adjusted for Incremental Cost Analysis							
TOTAL	3,872	-482	4,275	403	-755	3,880	8

The mitigation for dike field/slackwater impacts includes approximately 200 dike/revetment notches, maintaining or dredging the openings to 30 backwaters or side channels, modifying or

moving 75 disposal areas, and constructing islands in 30 locations. Specific examples of aquatic mitigation are shown in Table ES-4.

Table ES-5. Specific Examples of Aquatic Mitigation

Type of Mitigation	Number of Sites	Example of Projects
Avoid	25	Navigation mile 45.4-46.0. Avoid disposal in aquatic areas of AR45.3L-D; dispose on land or preferably on right bank. Navigation mile 46.8-49.2L. Utilize land within cells for disposal at AR48.0L-D and avoid aquatic areas. Navigation mile 124.8. Avoid disposal in AR124.8L-D and utilize in-channel disposal.
Minimize	63	Navigation mile 24.0-25.0L. Notch modified revetment (2) and modified dike (1). Navigation mile 169.4-169.7. Notch raised dikes (4). San Bois Creek NM 0.4. Create marsh 6" to 2-foot depth with disposal material, protect mussels Use of silt curtains for open water disposal in Arkansas and Oklahoma.
Avoid & Minimize	22	Recommend constructing island downstream at 90.5-91.0L behind underwater revetment. If proposed location must be utilized, place disposal off bank and create island(s) and notch backside of existing dikes. Navigation mile 180.4-181.3R. Extend disposal area upstream to raised dike at 181.5R and dispose along bank downstream of dike. Notch dikes (2). San Bois Creek NM 6.9. Expand island, design to avoid mussels, height of disposal will be 1-2 feet below water surface.
Avoid & Compensate	6	Navigation mile 32.2R. Maintain entrance to backwater channel by avoiding disposal and periodically dredging
Avoid & Minimize & Compensate	4	Navigation mile 94.3-96.3L. Avoid aquatic disposal in uppermost cells of AR95.5L-D, extend disposal area downstream to create a series of islands for a braided system and terns, notch existing dikes (5) to enhance backwater areas
Compensate & Minimize	6	Navigation mile 243.7-244.2L. Notch modified revetment and existing dike at upstream end of Hartman Lake to flow-through and fish passage
Compensate	61	Navigation mile 22.8R. Dredge entrance to Coal Pile Lake. Navigation mile 44.6L. Dredge a 0.5-mile entrance to Little Bayou Meto and 0.5-mile entrance at the upstream end of the Bayou. Navigation mile 408.9L. Dredge mouth of Billy Creek Cutoff. Navigation mile 442.L. Dredge lower end of oxbow.

Source: ERDC, 2005

Gravel bars are used by a variety of sensitive fish species and are considered important for shelter, spawning, food production and habitat diversity. Gravel bar surveys in proposed dredging locations indicated that a total of approximately 165 acres of gravel would be impacted in pools 5, 7, 9, 10 and 15. The specific locations of gravel in these pools are shown in Table 8-8 in Chapter 8 and also in Appendix C. The goal of mitigation would be no net loss of gravel substrate/habitat. This would be accomplished through strategic redeposition of gravel from within the navigation channel to locations adjacent to the channel and side channel locations, which would be determined by the involved agencies. The Tulsa District USACE has completed some preliminary modeling to determine the optimum locations to relocate gravel near dredge sites. Gravel deposition sites would then be monitored in subsequent years to determine what, if any, movement has occurred, or the level of sediment deposition on the re-deposited gravel substrates.

Mussel (unionid) surveys concluded that the largest impacts to beds would be in the Arkansas Post Canal. Surveys estimated that there are approximately 2 million individuals in the Canal and the majority of these mussels would be destroyed through dredging. Mitigation for these impacts includes: relocating approximately 30,000 individuals to Piney Bay in Lake Dardanelle where populations have been depleted by commercial harvesters, relocating approximately 60,000 individuals to backwater areas in Pool 2 and then using these individuals to recolonize the Canal, and perform monitoring to determine survival rates and health of the population. Throughout the remainder of the system, only scattered beds and patches of mussels were noted. The final mussel report is located in Appendix C and Table 8-9 in Chapter 8 summarizes the location of the beds and patches that are located near construction areas and the mitigation measures that will be used to protect these animals. Mitigation will primarily consist of avoiding specific areas, utilizing silt curtains, performing additional surveys, and monitoring and relocating bed or patches as needed, particularly in areas such as San Bois and Sallisaw Creeks that have been identified as sensitive.

ES.6.2.2 Long Term Monitoring and Adaptive Management

The MKARNS riparian, wetland, and aquatic ecosystems are complex and dynamic. Understanding of these ecosystems and the ability to predict how the river will respond to management actions is limited. This limited knowledge gaps results in uncertainty over how best to implement mitigation measures to achieve the desired outcome. Despite these uncertainties, the USACE must make decisions and implement plans. The purpose of long term monitoring and adaptive management is to develop a process framework for monitoring and managing the biological mitigation measures. The MKARNS Adaptive Management Plan will serve as a template for task requirements to achieve defined goals and measurable objectives to accomplish mitigation results. It is the ultimate goal of the Corps to achieve a functioning, self-sustainable ecosystem by mitigating for impacts as a result of the navigation deepening and flow modification project. Tables 8-9 and 8-10 in Chapter 8 provide summaries of long term monitoring and adaptive management, respectively.

ES.6.2.3 Threatened and Endangered Species

Based upon the best available information, the USACE has evaluated the impacts of its continued operation of its existing projects, operation of proposed projects, studies, and cumulative impacts on the 17 Federally listed species that have the potential to occur or do occur within the study area, and concluded there would be no effect on the following Federally-listed species: American alligator, gray bat, Indiana bat, Ozark big-eared bat, whooping crane, scaleshell mussel, piping plover, ivory-billed woodpecker, Arkansas River shiner, *Geocarpon*, western prairie fringed orchid, and harperella. This is due to the fact that the range of many of these species does not extend to the project area, the species is no longer found in the area, suitable habitat is not present on project lands, or the impacts were considered to be inconsequential.

The ivory-billed woodpecker was thought to be extinct until recently found in Monroe County, Arkansas within the Cache River National Wildlife Refuge and adjacent areas. Therefore, this Federally endangered species was not included in the Biological Assessment. However, the USFWS determined in their Biological Opinion that the proposed action is not likely to adversely affect this species.

The evaluation also concludes that continued operation of existing projects, proposed projects, studies, and cumulative impacts may have an affect on the following Federally listed species and/or their habitats: interior least tern, pallid sturgeon, bald eagle, and American burying beetle. The USFWS concluded that there is currently not enough available information to issue an opinion on the pallid sturgeon, and they are awaiting sediment-testing results before issuing an opinion on the bald eagle. Therefore, this opinion only addresses the least tern and the American burying beetle

Section 7(a)(2) of the Act requires federal agencies to ensure that any action authorized, funded, or carried out by such agency is not likely to: 1) jeopardize the continued existence of any endangered or threatened species, or 2) result in the destruction or adverse modification of critical habitat. The term "jeopardize the continued existence of" means to reduce appreciably the likelihood of both the survival and recovery of listed species in the wild by reducing the species' reproduction, numbers, or distribution. Jeopardy biological opinions must present reasonable evidence that the project would jeopardize the continued existence of the listed species or result in destruction or adverse modification of critical habitat.

After reviewing the current status of the American burying beetle and least tern, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the USFWS' Biological Opinion (BO) that the action, as proposed, is not likely to jeopardize the continued existence of either species and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for these species, and therefore, none would be affected. However, the proposed action would likely result in incidental take of American burying beetles and least terns.

The threatened and endangered species mitigation focuses on the least tern and American burying beetle. Per the USFWS' BO, mitigation measures for the least tern include a series of in-channel islands to be created through dredged material disposal within each river pool. For the burying beetle, the emphasis would be on avoidance and minimization of impacts.

ES.6.2.4 Cultural Resources

Because the USACE has determined that Feasibility Study-related activities may have an effect upon properties potentially eligible for inclusion in the National Register of Historic Places (NRHP), and has consulted with the Arkansas State Historic Preservation Officer (SHPO), the Oklahoma SHPO, and the Oklahoma Archaeological Survey (OAS) pursuant to Section 800.14(b) of the regulations (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act (NHPA)(16U.S.C. 470f); [and Section 110(f) of the same Act (16 U.S.C. 470h-2(f))], the USACE and the Arkansas SHPO agreed that subsequent to completion of the NEPA documentation, a Programmatic Agreement (PA) shall be implemented to satisfy the USACE's Section 106 responsibility for all individual aspects of the Feasibility Study. The USACE, Oklahoma SHPO, and the OAS agreed that a PA was not necessary for the USACE to satisfy Section 106 and 110 responsibilities for activities proposed as part of this project. In Oklahoma, the USACE would follow normal Section 106 procedures (as detailed in 36 CFR 800) for all undertakings that may have an effect on historic properties. If necessary, mitigation of historic properties that may be adversely affected by a project activity would be determined on a case-by-case basis in consultation with the Oklahoma SHPO and the OAS.

A PA will be prepared and implemented by the Little Rock USACE for the identification, evaluation and treatment of cultural resources adversely affected by the Proposed Action on the MKARNS in Arkansas. This PA is reproduced in Appendix D of this EIS.

Implementation of the Section 106 provisions and consultation with the Oklahoma SHPO and the OAS on a case-by-case basis will serve as mitigation and as such will reduce the level of potential impact to cultural resources to below the significance threshold.

The assumed (and preferred) mitigation is avoidance. Avoidance preserves the integrity of archaeological sites and protects their research potential (i.e., their NRHP eligibility). Avoidance of architectural resources may be accomplished through project redesign or construction of flood-control dikes or coffer dams around architectural resources.

Historically, Phase III data recovery of archaeological sites through professional techniques such as surface collection, mapping, photography, subsurface excavation, technical report preparation and dissemination, has been the standard mitigation measure. However, data recovery is labor intensive (i.e., costly) but may be necessary if NRHP-eligible sites cannot be avoided.

Mitigation measures may include, but not be limited to, Phase I survey, Phase II evaluation studies, Phase III data recovery, if required, monitoring the condition of archaeological sites on a yearly basis, and stabilizing archaeological sites.

Because intact prehistoric and historical archaeological resources that may contain sufficient information to be NRHP-eligible may occur, a Phase I archaeological survey is recommended prior to dredging, construction and/or modification of dikes and revetments, and creation of new disposal locations. The Phase I survey for terrestrial resources may consist of surface surveys in areas with good visibility or a series of shovel probes and/or backhoe trenches in heavily vegetated areas, to identify archaeological sites and to determine their extent and integrity.

Because submerged resources may be present that may contain sufficient information to be NRHP-eligible, a modified Phase I survey is recommended prior to dredging, construction and/or modification of dikes and revetments and use of new disposal locations. This modified Phase I survey would consist of intensive archival research to determine the potential for submerged

resources in the study area; preparation of a predictive model to determine low, moderate or high probability areas; and implementation of a Phase I remote sensing survey based on a sampling strategy for low, moderate and high probability areas.

ES.7 Conclusions

This EIS was prepared in accordance with the requirements of the National Environmental Policy Act, regulations promulgated by the President's Council on Environmental Quality (40 CFR 1500-1508), and Army Regulations.

The analysis of environmental consequences indicates that implementation of any of the Project Alternatives will not produce significant impacts, either by itself, or through cumulative effects of past, present, or reasonably foreseeable actions.

Based on the analysis and evaluation of the alternatives presented in this EIS, along with the information and analysis contained in the Feasibility Study Report associated with this study, the following alternative has been selected for implementation:

Alternative E: 1) Flow Management – Operations Only, 2) Navigation Channel Deepening – 12 ft. Navigation Channel Mouth to Catoosa, and 3) Navigation Channel Depth Maintenance – New Disposal Sites.

Consultation with regulatory agencies will be ongoing to ensure compliance with all Federal, state and local regulations and guidelines.